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BlueMat: Water-Driven Materials

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Biological materials achieve an exquisite diversity and functionality through just a small number of abundant chemical elements. While engineering materials primarily use specific, often unsustainable, chemical compositions to realize their functions, nature achieves unparalleled functionality through optimized architectures that span multiple length scales. Water, with its ubiquity and unique structural dynamics, plays a pivotal role as a "working fluid"in shaping the properties and functionality of nature's materials. Inspired by these marvels of nature, BlueMat will develop a novel class of sustainable, interactive, architected "Blue Materials"deriving their functionality from multiscale structures of hard matter interacting with water. This approach is internationally unique. We will mimic natural processes such as water-driven mechanical actuation, capillarity-driven water transport, humidity-dependent colors, and photocatalytic water splitting, as observed in animals and plants, and extend them to functionalities not found in nature, such as control of acoustic and electromagnetic waves, tunable thermal emission and electrical energy storage and generation. To this end, we will study and exploit novel effects, achieved, for example, through nanoconfinement of water. We will combine experiments with imaging and modeling from the atomic up to the device scale and bridge the gap between top-down and bottom-up fabrication methods to enable scalable production of Blue Materials. BlueMat raises and answers compelling and fundamentally new scientific questions. It promises a radically new concept to functionalize materials, and it will demonstrate the fascinating opportunities of this approach by a host of device-level applications. These include novel energy efficient windows and hydrovoltaic power generation, harvesting electrical energy from environmental processes or waste heat.

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